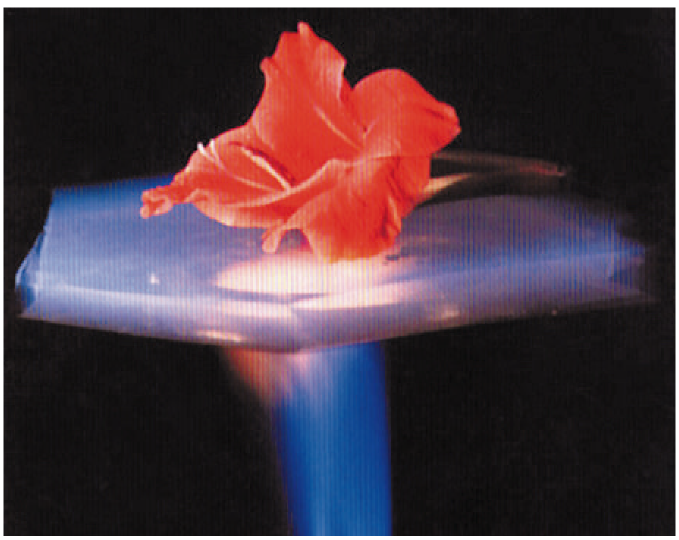
Aerogel: Working on a Clear View to the Future

Aerogel is an extremely effective, and extremely light insulator that, potentially, has hundreds of applications on Earth. It is 90-99 percent air, and if you could unfold a sugar-cube size block of it, it would cover a basketball court. A one-pound block of it can support a thousand pounds. A slab of it an inch thick can shield a human hand, or even a delicate flower, from the heat of a blowtorch. A single pane of this fascinating material used in a window would provide thermal insulation equal to that of up to 30 panes of conventional glass. Discovered in the 1930s by a Stanford University researcher, it is also the lightest solid known, having a density just three times that of air.



Though mostly air, Aerogel is an amazingly effective insulator.

Aerogel has been cited as a "Technology to Watch" by Fortune Magazine because of the more than 800 product applications identified for it. From satellites to surfboards, aerogel can provide extremely light-weight and extremely efficient insulation. Some of the more exciting possibilities are for optically clear aerogel, which can be used in applications ranging from residential windows to insulated covers for cameras and other sensors on satellites. Collaborative work is being done with Southern Research Institute, Berkeley National Labs and Argonne National Laboratory, and commercial interest has been expressed by Aspen Systems, Conoco, Inc., Dominion Energy, and Plastics Technology. In addition, technical information on aerogel has been provided to more than 50 companies. Currently, aerogel is known by names such as "pet cloud" and "solid smoke" because of its hazy appearance. This haze may come from having many different sizes of pores in the material.

Space research may produce a clear Aerogel, opening the door to untold commercial applications.

Aerogel is made from an alcohol-based gel containing silica particles, and in its raw form resembles a cube of gelatin dessert. This gel has to be dried without allowing it to collapse in on itself, which is done by soaking the gel in liquid carbon dioxide and then evaporating the alcohol and carbon dioxide at high pressure. This leaves a structure of silica particles with air between them. These pores, or spaces between the particles, make the material both light-weight and a good insulator. The research being done on STS-93 is helping researchers find methods of producing aerogel on Earth with uniform pores, so that it is as clear as glass.

Microgravity reduces convection (flows caused by temperature differences) and sedimentation (the rising of lighter materials and the sinking of heavier ones). In this unique environment, researchers can obtain data not possible to get on Earth with present technology. Preliminary research on a sub-orbital (sounding) rocket showed an improvement in the pores (the microstructure) of the material in comparison with ground-based samples after only seven minutes exposure to microgravity.

Data analysis from the aerogel research conducted on STS-95 is currently underway. In addition to experiments aimed at helping produce clear aerogel, 16 samples of carbon-based aerogels were also flown in partnership with the Southern Research Institute. All the samples solidified in microgravity, were catalyzed into gel on the third day of the mission, and produced material that will be tested for use as thermal protection on reusable launch vehicles.

Astronaut John Glenn training on the aerogel experiment for STS-95 with Project Manager William Powell of NASA's Space Product Development Team.

On STS-93, the Aerogel payload will be activated early in the mission by mixing two solutions in specially sealed syringes. The resulting mixture will then be allowed to gel over the course of hours to days in microgravity. The gels will be removed from the shuttle after landing and dried using liquid carbon dioxide and high pressure. The resulting aerogel samples will then be analyzed using a variety of analytical techniques, including porosity measurements and nuclear magnetic resonance imaging. Using this data, researchers hope to "clear the view" of Aerogel, helping to realize the full potential of this material to the benefit of all.

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